$$\frac{P}{V}=\frac{2\rho N_{\mathrm{b}}}{3\pi C_{\mathrm{D}}{}^{2}}\left(\frac{1-\alpha^{2}}{\alpha^{2}}\right)x_{0}^{3}\omega^{3}\qquad\left(\mathrm{W\,m^{-3}}\right)\tag{3.2}$$

Where ρ is the fluid density (kg m^{-3}), N_b the number of baffles per unit length of reactor (m^{-1}), α the baffle restriction ratio (= $(D_o/D)^2$, where D_o the baffle diameter and D the tube diameter), x_o the oscillation amplitude (m), ω the angular oscillation frequency (= $2\pi f$) and C_D a discharge coefficient for the orifice (normally taken as 0.7,[120–122] although the value depends on the baffle thickness and α[123]). Baird and Stonestreet (1995) suggested that the quasi-steady model was suited for high amplitudes (in the region of 5–30 mm) and low frequency (order of 0.5–2 Hz) oscillation.[119,124]

At higher oscillation frequencies (3 to 14 Hz) and lower amplitudes (1 to 5 mm), the quasi-steady model becomes ineffective at describing the power density. Baird and Stonestreet (1995)[125] proposed the eddy enhancement model, which is defined by:

$$\frac{P}{V}=\frac{1.5\rho x_{0}^{2}\omega^{3}l}{L\alpha}\qquad\left(\mathrm{W\,m^{-3}}\right)\tag{3.3}$$

where L is the baffle spacing (m) and l is the mixing length (m), with the same order of magnitude as the column diameter. The challenge for this model would be the determination of the mixing length. The recent CFD work revealed that the application range originally specified for each model was a myth rather than a fact; both models gave very similar predictions of power density for a wide range of geometric and operating conditions, and can be used interchangeably with high confidence.[126]

The power density of a stirred tank crystalliser is defined in[127]

$$\frac{P}{V}=\frac{P_{\mathrm{o}}\rho N_{s}^{3}D_{s}^{5}}{V_{\mathrm{L}}}\qquad\left(\mathrm{W\,m^{-3}}\right)\tag{3.4}$$

where N_s is the speed of the stirrer (rps), D_s the diameter of the stirrer (m), V_L the volume of liquid in the STC (m^3) and P_o is the dimensionless power number of the agitator that depends on the type and diameter of blades and the distance with respect to the bottom of the vessel.

It should be stressed that the above equations for evaluating power densities were derived from theories and experimental validations are much needed. Recently a CFD work generated data on pressure drop and phase angle (between pressure and velocity) in a COBR, which were used to validate both power density equations.[126]

3.4 Design and Operation of Continuous Oscillatory Baffled Crystalliser

When cooling crystallisation is carried out in batch crystallisers, be it a lab or production scale, the whole mass of solution is cooled from a starting to an end temperature; this can be regarded as a temporal domain process. The operational principles in continuous crystallisation in COBC are different from the aforementioned in that